Very Long Wavelength $In_xGa_{1-x}As/GaAs$ Quantum Well Infrared Photodetectors

S. D. Gunapala a, K. M. S. V. Bandara b, B. F. Levine b, J. K. Liu a, J. S. Park a, and T. L. Lin a

a. Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109
b. AT&T Bell Laboratories, Murray Hill, NJ 07974

ABSTRACT

For all of the GaAs based Quantum Well Infrared Photodetectors (QWIP) which have been demonstrated so far, GaAs is the low band gap *well* material and the barriers are *lattice matched* $Al_xGa_{1-x}As$, $Ga_{0.5}In_{0.5}P$ or $Al_{0.5}In_{0.5}P$. However, it is also interesting to consider GaAs as the barrier material since the transport in binary GaAs is expected to be superior to that of a ternary alloy, as was previously found to be the case in the $In_{0.53}Ga_{0.47}As/InP$ binary barrier structures [1]. To achieve this we have used the lower bandgap non-lattice matched alloy $In_xGa_{1-x}As$ as the well material. Excellent quality strained layer QWIPs having compositions $In_{0.15}Ga_{0.85}As/GaAS$ and $In_{0.2}Ga_{0.8}As/GaAs$ were grown by molecular beam epitaxy. The measured absolute responsivity of these QWIPS increases nearly linearly with bias reaching 0.63 A/W at Vb = -150 mV. The measured optical gain is also very large reaching g = 12 at Vb = -100 mV which corresponds to a small capture probability of 2.7%. This excellent hot-electron transport is due to the high mobility of binary GaAs barriers. The measured defectivity of these unoptimized detectors ($\lambda_c = 20\ \mu m$) at temperature T = 20 K are about lx 10^{11} $cm\sqrt{Hz}/W$. This demonstrates the excellent carrier transport of the GaAs barriers and the potential of this heterobarrier system for very long wavelength ($\lambda > 14\ \mu m$) QWIPS.

1. S. D. Gunapala, B. F. Levine, D. Ritter, R. A. Harem, and M. B. Panish, Appl. Phys. Lett. 58,2024 (1991).